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$$= \frac{8Aa^2b}{3B} \{ [1 + B^2/a^2] E[B/a, \frac{1}{2}\pi] - [1 - B^2/a^2] F[B/a, \frac{1}{2}\pi] \}.$$

Let $x = a \sin \theta$ in (2).

$$\begin{aligned} \text{Then } V &= 8Aab \int_0^{\frac{1}{2}\pi} \sqrt{1 - (a^2/B^2) \sin^2 \theta} \cos^2 \theta d\theta \\ &= \frac{8AB^2b}{3a} \{ [1 + a^2/B^2] E[a/B, \frac{1}{2}\pi] - [1 - a^2/B^2] F[a/B, \frac{1}{2}\pi] \}. \end{aligned}$$

MECHANICS.

121. Proposed by W. J. GREENSTREET, M. A., Editor of The Mathematical Gazette, Stroud. Gloucestershire, England.

Two equal scale pans of mass m hang at rest over a smooth pulley. An inelastic particle, mass M , is dropped from a height h into one pan, and simultaneously another of equal mass and elasticity e is dropped from the same height into the other. Prove that every impact occurs when the pans are in their original positions, and find the total space described by either pan before motion ceases.

Solution by G. B. M. ZERR, A. M., Ph. D., Professor of Chemistry and Physics, The Temple College, Philadelphia, Pa.

The velocity of each particle just before impact $= \sqrt{(2gh)}$.

The velocity of first rebound of elastic particle $= e\sqrt{(2gh)}$.

The velocity of second rebound of elastic particle $= e^2\sqrt{(2gh)}$.

The velocity of n th rebound of elastic particle $= e^n\sqrt{(2gh)}$.

The elastic particle imparts a velocity to the scale pans at first impact $= \frac{M(1+e)}{2m+M}\sqrt{(2gh)}$, at the second impact a velocity $= \frac{Me(1+e)}{2m+M}\sqrt{(2gh)}$, at the n th impact a velocity $= \frac{Me^{n-1}(1+e)}{2m+M}\sqrt{(2gh)}$.

The inelastic particle imparts a velocity to the scale pans at first impact $= \frac{M}{2m+M}\sqrt{(2gh)}$.

Resultant velocity of these two particles at first impact $= \frac{Me}{2m+M}\sqrt{(2gh)}$.

The acceleration caused by inelastic particle $= \frac{Mg}{2m+M}$.

The time required for the scale pans to return to their original positions

$$= \frac{2Me}{2m+M}\sqrt{(2gh)} / \frac{Mg}{2m+M} = 2e\sqrt{(2h/g)}.$$

The time required for the elastic particle to return to the same position $2e\sqrt{(2gh)/g} = 2e\sqrt{(2h/g)}$.

Therefore, second impact takes place in original position.

As the scale pans have a velocity $= \frac{Me}{2m+M} \sqrt{(2gh)}$, the resultant velocity after the second impact

$$= -\frac{Me(1+e)}{2m+M} \sqrt{(2gh)} - \frac{Me}{2m+M} \sqrt{(2gh)} = -\frac{Me^2}{2m+M} \sqrt{(2gh)}.$$

The time required for the scale pans to return to their original position

$$= \frac{2Me^2}{2m+M} \sqrt{(2gh)} / \frac{Mg}{2m+M} = 2e^2 \sqrt{(2h/g)}.$$

It takes the elastic particle a time $= 2e^2 \sqrt{(2gh)/g} = 2e^2 \sqrt{(2h/g)}$.

Therefore, the third impact takes place in original position.

Proceeding thus, we find the resultant velocity after the n th impact $\frac{Me^n}{2m+M} \sqrt{(2gh)}$, and the time required for the scale pans to return to the original position $= 2e^n \sqrt{(2h/g)}$.

Therefore, every impact occurs in the original position.

Space passed over by scale pans between n th and $(n+1)$ th impact

$$\frac{Mg}{2m+M} \times \frac{2he^{2n}}{g} = \frac{2Mhe^{2n}}{2m+M}.$$

Therefore, total space passed over $= \frac{2Mh}{2m+M} (e^2 + e^4 + e^6 + e^8 + \dots)$

$$\therefore S = \frac{2Mh}{2m+M} \cdot \frac{e^2}{1-e^2}.$$

The elastic particle passes over a space S where

$$S = h + 2he^2 + 2he^4 + 2he^6 + \dots = \frac{1+e^2}{1-e^2} h.$$

The time required for scale pans to come to rest

$$= 2\sqrt{\left(\frac{2h}{g}\right)} (e + e^3 + e^5 + e^7 + \dots) = 2\sqrt{\left(\frac{2h}{g}\right)} \cdot \frac{e}{1-e^2}.$$

The time required for the elastic particle to come to rest

$$= 2\sqrt{\left(\frac{2h}{g}\right)} \cdot \frac{e}{1-e} + \sqrt{\left(\frac{2h}{g}\right)} = \sqrt{\left(\frac{2h}{g}\right)} \cdot \frac{1+e}{1-e}.$$